Development of Freeze-dried Catalysts for Hydrogen and Direct Methanol Fuel Cells

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The effort to develop polymer electrolyte fuel cells (PEFC) continues to accelerate. PEFC performance problems imposed by the need to use a flexible fuel source (e.g. reformed methanol for portable power or gasoline for automotive PEFC's) ensure a substantial amount of future research to develop improved membranes and catalysts. Yet the catalyst remains one of the most important components of the PEFC. Currently, Pt and Pt/Ru alloy catalysts are commercially prepared via a colloidal precipitation route. As a consequence, it is often difficult to control particle size and dispersion onto a carbon support with a high degree of reproducibility. This is particularly true for CO-tolerant, direct methanol Pt/Ru alloy catalysts prepared for the anode. The large difference in reduction potentials between Pt and Ru chloride salts presents an experimental challenge because post anneals at elevated temperatures are necessary in order to alloy the two metals together following precipitation and drying. As a result of this potential for a lack of reproducibility between batches of typical, commercially available catalyst material, we have found it necessary to tightly control the properties of the Pt and Pt/Ru catalysts. To do this, we have recently begun to make supported and unsupported Pt and Pt/Ru catalysts in-house using an ultrasonic freeze dried approach. In this process, solution precursors are atomized in to liquid nitrogen using an ultrasonic nozzle. The frozen snow is then freeze-dried and the catalyst subsequently formed from the powder precursor by hydrogen reduction. We will present our initial characterization data of Pt and Pt/Ru catalysts and show PEFC performance data using these materials.